Howard, W. N. 1980

Experimental Seining and Netting in the North Basin of Lake Winnipeg, 1963 to1967, With Special Reference to Sauger and Whitefish.

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ABSTRACT

In the summer of 1967, an experimental seining and netting project was conducted in the north basin of Lake Winnipeg. The purposes of the study were to indicate whether a predator-prey relationship existed between sauger and young whitefish and to learn more about the life history and frequency of occurrence of sauger in Mossy Bay. A hoop seine four feet in diameter equipped with a twelve foot bobbinet bag was used to capture young whitefish. Standard net gangs were used to take fish samples for stomach analysis and general sampling.

In June, young whitefish were noted in warm protected bays. By July, the whitefish had dispersed and could not be located by seining or by gut sampling all piscivores taken in experimental nets. Only one whitefish was positively identified from the stomach of a sauger following thirty net sets involving 11,000 yards of net.

Sauger taken in July were significantly smaller, younger, less mature but more abundant than those taken previously in June. It can only be assumed that the faster growing and maturing sauger were sampled while spawning in June or that two different populations of sauger co-exist in the north basin. Growth rates were slightly higher for

those fish sampled in June but their growth potential appeared greater. It is apparent that these sauger have been exploited and further exploitation is not recommended in the north basin. Possible avenues for further research are suggested.

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INTRODUCTION

Over the years there has been considerable indication that sauger, *Stizostedion canadense* (Smith) frequent the north end of Lake Winnipeg. They have been well represented in the commercial catches from trap nets and the legal 5 in. mesh gill net fishery of this area. On occasion, experimental gill nets have caught large numbers of saugers. Furthermore, fishermen and tagging programs have repeatedly indicated a fall southward migration of saugers from the north basin into the Channel area.

In view of the declining whitefish stocks, *Coregonus clupeaformis* (Mitchell), in Lake Winnipeg, it has become necessary, for management purposes, to learn more about this sauger population. It has been suggested that the whitefish are doomed, that sauger could be partly responsible for this, and that the north end of Lake Winnipeg should be managed for saugers and walleyes, *Stizostedion vitreum vitreum* (Mitchell). If a strong predator-prey relationship exists between whitefish and sauger, it is unrealistic to expect the lake to maintain an abundance of both species. It has been suggested that small mesh nets should be allowed on the traditional whitefish grounds to harvest saugers. Whitefish and walleye stocks could be further depleted by such a drastic change in regulations.

In the summer of 1967, an attempt was made to determine (a) whether a strong predator-prey relationship existed between the piscivorous sauger and young whitefish, and (b) to learn more about the population

structure and life history of the sauger especially in Mossy Bay. This report deals with findings of this study and in addition considers pertinent data, collected in 1963, 1965 and 1966, that have not been analyzed previously.

METHODS

In 1967, the existence of a predator-prey relationship between sauger and young whitefish was tested through stomach analysis of saugers taken in known or suspected whitefish areas. Initially it was hoped that whitefish fry could be located by seine, and gill nets for saugers could be set in their midst. Subsequent stomach analysis of all piscivores might then indicate food chain relationships. When whitefish fry were located, the above procedures were followed.

A hoop seine 48 inches in diameter and equipped with a 12 foot long bobbinet bag was employed in an effort to locate young whitefish. The hoop was equipped with a rounded bottom deflector plate and two fixed vertical lateral wings. The wings were designed to "catch" water and channel it through the 1/8 inch bobbinet bag. By regulating the angle of the hoop and the speed of the boat, the seine was operated at various depths. The angle of hoop drag was regulated by shortening or lengthening the three towlines that were attached to the edge of the hoop rim. The three tow lines were consolidated into a single tow rope approximately 30 feet forward of the seine.

Initial seining was attempted using an 18 foot skiff and a 33 H.P. outboard motor. However, following a tow period it was impossible to manually pull in the seine and still maintain sufficient tension and forward motion of the bag to prevent the catch from escaping. Subsequently, the hoop was towed from the winch aboard the research vessel. Towing was

attempted in both forward and reverse gears. Forward towing was finally adopted as the direction of the research vessel could not be controlled while travelling in reverse.

For each seine haul, data such as area, depth of link setting on hoop, speed and catch were recorded. Seining time ranged from 5 to 20 minutes.

Areas seined were Sturgeon Bay, Spider Island outside the reefs and Black River (Figure 1). Sturgeon Bay was chosen for this experimental work because approximately 55 million young whitefish had been released into the Dauphin River at the end of May. The latter two locations were selected as many fishermen claim the reefs in these areas are frequented by spawning fish.

The mesh size of the experimental gill nets were 1 1/2, 2, 3, 3 3/4, 4 1/4 and 5 inches (stretched measure) and all nets were approximately six feet deep. Usually, all net sizes were set together in a single gang. All nets were 50 yards in length with the exception of the 4 1/4 inch and 5 inch mesh; these were 100 yards each. The nets were usually set overnight and were in the water for approximately 20 hours.

Thirty experimental gill net sets were made during the summer of 1967. Eighteen of these sets were made in Mossy Bay. Mossy Bay is defined here as that area lying to the north of a line drawn between Eagle Island and Mossy Point (Figure 1). Netting areas ranged from Gravel Island and Hay Point (in Sturgeon Bay) to Horse Island, Mossy Bay, Spider Island and Poplar Point (Figure 1). One surface set was made in Mossy Bay each month during June and July.

Net sets were made at various depths and over various substrates. The number of fish caught in each mesh size was recorded for each species. For all saugers, whitefish and walleyes, scale samples were taken along with data on sex, state of maturity, length, weight, gut content, mesh size, water depth, bottom type and water temperature. Gut contents were usually analyzed at the time of sampling. Fish suspected of being "coregonids" were either closely studied on the spot or preserved in 70% alcohol for subsequent identification.

Initially, all June sauger samples were aged by Mr. H. Metheringham while Mr. W. Musker read the July scales. As a large difference in sauger size at a given age was noted between the June and July samples (see discussion), Mr. Musker was requested to read the June samples as well.

RESULTS AND DISCUSSION

Seining and netting

In June, 1967, hoop seining was not required to locate whitefish fry. During the second week of June, fry approximately one-half inch in length were noted and sampled in the Dauphin River area. Identification was possible by comparing the sampled fish to Dauphin River Hatchery stock. Whitefish fry had been released from the hatchery on May 27, 1967. These, or natural stocks, were noted approximately one-half mile upstream from the Dauphin River Hatchery. Others were noted at the mouth of the river and in shallow, warm, protected bays within two miles of the river mouth. At this stage in their life, the fry were still rather transparent and swam slowly, close to the surface and in a "head up" position. This behavior made them very vulnerable to predation by terns. The whitefish fry were usually found within 12 feet of the shoreline.

Water temperatures in which the fry were found ranged from $64^{\circ}F$ in the river to $57^{\circ}F$ in Sturgeon Bay.

In the last week of June, whitefish fry were also located at the mouth of a small river that entered Lake Winnipeg just east of the Spider Island fish stations. Water temperature inshore was $55^{\circ}F$. Surface water temperatures taken the following day, approximately five miles southwest of Spider Islands, were $47 \pm 2^{\circ}F$.

Whitefish fry were also located in the warm water ($60^{\circ}F$) of a protected bay near the Poplar Point fish station. This bay is located

east of the fish station and is often used as a harbour by the patrol boats.

June experimental netting was conducted in all areas where whitefish fry were observed. A six hour net set (not indicated in Figure 1) in the Dauphin River caught one walleye and one pike, *Esox lucius*. The sets could not be left for a longer period as they quickly became fouled with debris. These two fish caught in the above set were gut sampled but neither had fed on whitefish fry.

On June 11, an overnight net set at Gravel Island in Sturgeon Bay produced 721 fish. Of the 636 perch, *Perca flavescens*, taken in this set, 82% had empty stomachs. The rest of the perch had fish remains, fish eggs, crayfish and mayfly larvae in their stomachs. Nine saugers and five walleyes taken in this set had not fed on whitefish fry although they had spawned and were actively feeding. Perch predation may have been curtailed as perch spawning was in progress.

On June 12, the nets were moved to a small bay close to Hay Point. This location was closer to the Dauphin River and whitefish fry were abundant. The catch in this shallow water area was considerably reduced and of the 93 piscivores taken, none had fed on whitefish fry.

In June, the gut contents of approximately 40 walleyes were sampled at the Dauphin River fish station. These were commercially caught fish taken near the Mantagao River. No young whitefish were found in these stomach samples.

At Spider Island and Poplar Point, stomach samples from piscivores such as saugers, walleyes, and pike failed to reveal predation upon

whitefish even though the experimental nets were set close to, or in the midst of, whitefish fry.

From our June sampling, it was apparent that young whitefish were not the "targets" of piscivores. Fish caught in the proximity of whitefish fry had either not eaten or had chosen food items that were larger or more conspicuous than the small and rather transparent whitefish. Perch and sauger predation may have been curtailed because some of these fish were still spawning and the whitefish fry frequented shallow beach areas where the larger fish possibly would be reluctant to venture.

In June, minnows (mainly emerald shiners, *Notropis antherinoides*,) and trout-perch, *Percopsis omiscomaycus*, were the dominant food items of feeding sauger. Actual percentages for all areas were: fish remains and minnows, 66.2%; trout-perch, 8.1%; mayflies, 4.0%; chironomids, 8.4%; others (fish eggs, caddisflies and leeches), 13.5% (see Table 7).

In July, whitefish fry could not be observed in any of the areas that were frequented by these fish in June. Seine hauls were made in the deeper waters of Sturgeon Bay, off Spider Island and the reefs near Spider Island and Black (Mukutawa) River. The seine was rather awkward to set but it effectively caught a good assortment of aquatic organisms. The results of a typical series of hauls made in Sturgeon Bay are shown in Table 1.

Some seine hauls in Sturgeon Bay resulted in the capture of large numbers of small cladocerans (possibly *Leptodora*). These cladocerans were often packed to a depth of approximately four inches in the cod end

of the net. Fry, identified as newly hatched perch, were abundant in the same areas as the cladocerans.

Several emerald shiners, up to three inches in length, were also taken. No whitefish were taken with this seine even though their size and activity would fall between the range of those organisms sampled by this means. By July, the whitefish fry have apparently left the shallow protected bays and have either become widely dispersed or frequent unsampled areas.

In July, experimental nets were set fairly close to those areas where whitefish fry had been noted in June. Few sauger were taken in Sturgeon Bay. Those that were taken were feeding lightly on young perch and mayfly larvae. Tullibee, *Coregonus* sp. and perch were abundant. The tullibee were feeding on cladocerans and mayfly larvae while the perch were feeding heavily on mayfly and caddisfly larvae.

In July, at Poplar River, two experimental net sets were made even though whitefish fry could not be located. One set was made in the reef area near shore while the second set was made at the edge of the reef area and the main body of the lake. Although 116 saugers were gut sampled in these areas, none had fed on whitefish. A large mayfly emergence was in progress and most of the saugers had been feeding heavily on these. Saugers taken near the main basin were feeding heavily on young perch, emerald shiners and mayflies.

For the overall area, in July, the food composition of feeding saugers was: fish remains and minnows, 53.4%; mayflies, 9.9%; trout-perch,

9.2%; flathead chub, *Hybopsis gracilis*, 6.5%; tullibee (and whitefish), 4.5%; perch, 2.1%; others (fish eggs, caddisfly larvae and leeches), 12.3%. On only one occasion was a whitefish positively identified from the stomach of a sauger. This whitefish was approximately four inches long and was taken from a sauger that was caught in 18 feet of water just off Mossy Point.

It cannot be stated that an active predator-prey relationship does not exist between young whitefish and piscivorous fish. Such a relationship may exist at a different whitefish size or during the fall and/or winter. From our July results it might be assumed:

i) that net sets were made in areas not inhabited by young whitefish;

ii) that whitefish fry, at that size and season, are not actively sought after by piscivorous fish, or

iii) that the distribution of young whitefish and saugers, during the period sampled, differed in time and/or place.

Research of this type should be continued. Attempts to locate young whitefish in July and August could be beneficial in determining their distributional behavior and the possibility of predation at sizes and in areas not considered by this preliminary study. A smaller seine that could be handled from a skiff might be appropriate for investigating inshore and reef areas. In late July and August, more extensive seining in deep water areas might be fruitful. Evening and night seining should also be considered. Faber (1967) found that the majority of species studied in Wisconsin lakes dispersed into the limnetic region after hatching and could be collected at night. Gut analysis of saugers caught

in winter should also be considered.

Another aspect to investigate could be the tern - fish relationship. Tern populations are extensive over most of Lake Winnipeg. They are not scavengers yet they are protected by federal law. The surface swimming behavior of young whitefish could make them prime targets of these diving, fish-eating birds. It was noted, for example, at Spider Island, that there was an obvious scarcity of small fish in the protected bays of these islands and that an increase in fish numbers could be noted in areas more remote from this tern nesting ground. It would be interesting to gut sample terns when the distribution of whitefish fry and terns coincide. If an active predator-prey relationship could be indicated, it might be beneficial to adapt measures that might restrict tern numbers or to investigate the feasibility of holding whitefish fry in the hatchery to a stage when their surface swimming behaviour is less pronounced.

Ageing

During the early analysis of the 1967 experimental sauger data, it was noted that June saugers of a given age appeared to be significantly larger than those caught in July. For example, saugers caught in June appeared to be about one inch longer in fork length than those caught in July. It was also noted that Mr. Metheringham had read the scale samples collected in June while Mr. Musker had read the July samples. To determine whether the observed difference in saugers at a given age

was due to differences in ageing techniques, a chi-square test was applied to ageing results that each scale reader had produced from a sample of one hundred July scale samples. The chi-square test indicated a highly significant difference in ageing results and the null hypothesis that the relationship between ageing and reader were independent had to be rejected. As the June samples represented the smaller number of samples to reread, Mr.Musker was asked to reread these and the results were used in the final analysis. The new results, though different, did not change the overall picture. That is, the June saugers of a given age were still larger than those sampled in July.

Netting - all areas

Experimental gill nets do not sample randomly and therefore, their results are a poor indication of population structure and species composition. Gill nets are usually selective for fish of a particular girth; although considerable variation arises from fish that are caught but not gilled (McCombie and Fry, 1960). Therefore, the efficiency or catch from a gill net often varies with the body morphology of a species and the various size classes of a particular species. This is evident throughout the catch results presented here (for example, Tables 2 and 3). Catch results are also affected by degree of fish movement and distribution in time and space (see section on distribution).

The frequency of catch for all species taken in experimental nets in 1967 is recorded in Table 2 in terms of frequency per 100 yards.

Species extensively sampled in this study were saugers, walleyes, and whitefish. Data for these species are shown in Tables 3 to 9. The 1967 experimental results for these three species were recorded separately for Mossy Bay in both June and July (Tables 10 to 20).

Sauger catch and growth-all areas

The sauger catch per 100 yards of net was greater in July than in June but the average weight of saugers caught in July was lower (Table 3). The average weight of saugers, based on all experimental sampling, weighed 0.95 pounds in June and 0.50 pounds in July. The greatest percentage of the catch was taken from 3 inch mesh in June but from 2 inch mesh in July. This might indicate that a spatial separation and shift in the younger and older sauger populations occurred in the inshore areas between June and July.

The mean weight to mean age ratio, considering the overall catch from experimental nets, was higher in June, the saugers were larger in a disproportionate manner. Saugers sampled in July were 16% younger and 47% lighter than in June. Part of this difference could be due to the fact that experimental fishing was conducted inshore where spawning activity was occurring in June. We could have been sampling faster growing and maturing saugers that were full of spawn in June but not in July. However, aside from weight, length data in Table 6 confirms the fact that larger saugers were encountered in June. Due to the extra month of growth by July, the above trends would normally be reversed. This anomaly might also indicate that a different sauger population was

sampled in June than in July.

The possibility of a separate population of saugers that normally inhabits the open, deep-water areas of the north basin should not be discounted. Whitefish fishermen report gilling the odd large sauger in deep water in 5 inch mesh. Large numbers of large saugers are sold at George Island and other fish stations during the early part of the whitefish season when fishermen are fishing inshore. These saugers are usually full of spawn and individual weights range up to four pounds. Saugers of this size are rarely observed in the fall fishery.

Linearity between mesh and fish size was not apparent in the larger mesh sizes. That is, for the larger mesh sizes, there was an inverse relationship between mesh size and both sauger age and weight (Table 3). This results from the fact that a large number of small saugers do not gill but, especially in turbid waters or during a storm, become entangled by the teeth. Consequently, there was a decline in the percentage of saugers that were mature in the largest mesh size. This was especially true for females (Table 7).

The male to female ratio was approximately 1:1.3. Young saugers are often difficult to sex and, as many were not sexed due to this, a certain error percentage should be expected. Saugers older than 2+ are usually sexed with comparative ease.

Male saugers mature earlier than females (Tables 6 and 7). The percent of the saugers mature in June, in most age groups, differed markedly from the percent mature in July (Tables 6 and 12). This might further suggest that a faster maturing population of large saugers

was sampled in June. The difference in seasonal maturity can be exemplified by considering the 2+ saugers (Table 6). In June, 70.6% of the 2+ saugers were mature while only 23.6% of the 2+ males were mature in July. Part of this discrepancy could be due to faster growing and maturing saugers that enter the shallow water netting area for spawning purposes. Possibly by July, the spawners had dispersed into deeper water and younger age groups had moved back into the netting area.

Sauger feeding habits varied between June and July. In June, 18.1% of the saugers that were sampled had food items in their stomach. The percentage increased to 43.2% in July. This difference may be due to sauger spawning in June. Both the quality and quantity of food consumed increased between June and July. The most dominant food items are listed in Table 7 in order of descending frequency of occurrence. Sauger size did not appear to influence feeding trends. The food of saugers of all sizes was dominated by fish. This was especially true in July. Chironomid larvae was a common food item in June but by July, this was commonly supplemented by mayfly larvae.

Walleye catch and growth - all areas

Walleyes were most frequently caught in 3 inch mesh (Tables 2 and 4) and the linearity between fish size and mesh size was fairly well defined. In the summer of 1967, walleyescaught in 3 inch mesh averaged 3.54 years of age and 1.06 pounds (Table 4). From this limited sample, we would expect approximately 22% of the males and 6% of the

females to be mature (Table 8) when obtained from a 3 inch mesh.

Only ten walleyes were taken in 4 1/4 inch mesh. The average weight of 1.84 pounds (Table 4) is somewhat larger than those taken in experimental nets at Dauphin River (1.52 pounds) in July, 1966 (Table 19). Walleyes taken from 4 1/4 inch mesh, in 1967, showed a low rate of maturity. Fifty percent of the males and 37.5% of the females were mature (Table 8).

A similar number of walleyes were feeding in June (53.2%) as in July (54.8%) and no trend was apparent in the feeding rate of the young or older walleyes (Table 8). Fish was usually the dominant food item (Table 8).

Whitefish catch and growth - all areas

With regard to Table 5 and considering all 99 whitefish taken in the summer of 1967, a direct relationship existed between average fish size and mesh size. Whitefish were most frequently taken in 4 1/4 inch mesh where the average weight was 1.69 pounds at approximately 3.9 years. The results also indicate that females mature faster than males (Table 9) but this is not supported by previous work (Howard, 1974).

A high percentage of the whitefish were feeding in both June (71.7%) and July (67.4%) while the younger whitefish appeared to be the more active feeders (Table 9). Qualitatively, the whitefish fed diversely on invertebrates (Table 9).

In June, large number of whitefish were taken by an inshore commercial fishery in the north basin. At this time, the inshore

distribution of whitefish was probably related to a coincident abundance of amphipods. This relationship was noted from both experimental and commercial samples taken in June near Spider Island. In July, water temperatures rise and the whitefish move to deeper water. Consequently, the major food items were those found in deeper water. The dominant food items eaten by whitefish in July were snails and clams (Table 9).

MOSSY BAY SAUGER

Catch and growth - 1967

Many of the trends noted earlier for saugers caught in all areas of the north basin were also apparent in Mossy Bay (Tables 10 to 12). This was true with respect to net selectivity, average age, sex ratio, feeding behavior and growth for the June and July samples. However, in Mossy Bay, the number and weight of saugers caught per 100 yards of net was greater than for all areas combined (Tables 3, 10 and 11). The average weight for all areas combined was only slightly greater (0.95 pounds) in June. This slight increase was probably due to a number of large spawners taken in the larger mesh sizes. It should be noted that a higher percentage of saugers were mature (at a given age) than when saugers from the whole area were considered (Tables 6 and 18).

Length and weight data for June and July have been plotted in Figure 2. Measurements were converted to millimeters to indicate more clearly the consistent differences between June and July data. If 95% confidence limits are applied to this data, the only overlap between the June and July data occurs with the 1+ and 6+ age groups. This

results because of the small sample size for each of these age groups.

The consistent difference between the June and July data is also indicated by the length-age regressions (Figures 3 and 4). The length-age regressions for June are described by the equation:

$y = 6.36 + 1.693\ (x)$ and $x = -3.72 + 0.588\ (y)$ while the length-age regressions for July are described by the equations:

$y = 5.17 + 1.612\ (x)$ and $x = -3.11 + .612\ (y)$. The x and y prediction lines (Figures 3 and 4) are almost coincident which indicate that the data are well described by linear correlation. These high correlation values are indicated by sex and season in Figure 5.

To determine whether sauger size in June was significantly greater than in July, a "t" test was conducted on the overall mean lengths for June and July (Table 12). A "t" value of 14.69 was calculated which exceeds the critical value of 1.96. Therefore, we must reject the null hypothesis that the sauger population sampled in June was the same as that sampled in July.

Females in June and July were larger at a given age than were males (Table 20 and Figure 5). Growth rates, as indicated by slope were similar (Figure 5). This would be expected for a common species taken from a common area. However, the growth rate of saugers sampled in June did not appear to decline as rapidly as those sampled in July. Thus, there was even greater divergence in size in the older fish and a greater growth potential was indicated for those saguers sampled in June. This evidence was pursued by use of a Walford plot (Walford, 1946). Sauger growth rates were similar ($K = .94$ for June and $K = .92$ for July)

but fork length at infinity ($L\infty$) for the June sample was approximately 100 mm (3.94 inches) longer than for saugers in the July sample (Figure 6). Applying this information to the prediction equation for x, the expected longevity of June and July saugers are 16 and 15 years, respectively.

As size at a given age was greater in June, it may be concluded that, in June, we either selectively sampled the faster growing and maturing saugers with a greater theoretical growth potential or we sampled two distinct populations. Anatomical, genetic and serological studies might help to deduce whether the latter hypotheses is correct.

July Mossy Bay Sauger - 1963 - 1967

Length and weight data show considerable variation (Tables 13 to 16). There was evidence that saugers from two different size groups, and possibly two different populations,were involved in the July, 1963 sample. When these data were plotted, the rapid rise between age groups 2+ and 4+ produced a flattened "S" shaped curve (Figure 7). The low mean fork length for the overall 1963 sample resulted from the large number of young fish in the sample.

The average size of saugers caught in July, 1963 and 1967, compare favourable (Tables 14 to 16) when overall sample weights and fork lengths are compared in relation to mesh size. When age is considered, the 1965 saugers appear to be considerably larger in size than those taken in 1967. However, the sauger scales in 1965 and 1967

were not read by the same scale reader and, again, the apparent difference could be due to this.

Similarily, erroneous ageing may be responsible for the odd results obtained in the July, 1966 sample when catch by mesh size is considered. Saugers sampled in July, 1966, were larger than those sampled in July of other years (Tables 14 to 16). This fact was not evident when size at various ages is compared from 1963 to 1967. It is possible that the sauger population sampled in July, 1966 was the same population as that sampled in June 1967.

Sauger distribution - Mossy Bay

All net sets, except two, were made on the lake bottom. Once in June, and again in July, a regular gang of nets were floated at the surface by attaching salmon corks at intervals along the cork line.

In June, the surface net set was made with a regular gang of nets approximately 4.5 miles south of The Gaps and suspended over 40 feet of water. At the same location, and using a similar gang of nets, a bottom set was made. Both nets were left for one night. No sauger were taken in the surface set while 51 saugers were caught in the bottom set. The total surface catch was 80 tullibees and 4 yellow perch while the bottom catch involved walleyes, saugers, tullibees, pike and yellow perch. Most of the saugers in the bottom set were in spawning condition and it was assumed that spawning was in progress as most of the saugers were near the lead line. The date was June 24, 1967, and the bottom water temperature was 46^{o}F.

In July, rough weather prevented the setting of a surface set in the same general area as in June. However, an overnight bottom set was made in the same general area and resulted in a catch of only 14 saugers.

In July, a surface set was made inshore near Mossy Point over approximately 15 feet of water. This resulted in a catch of 7 saugers but this catch could have been influenced by the shallowness of the set. In the same general area, a bottom set extending into 18 feet of water resulted in a catch of 196 saugers.

The above results indicate that Mossy Bay saugers are generally distributed close to the bottom. Eschmeyer (1950) found that saugers, in June, were most abundant in water that was 35 feet deep or less. By late July, most saugers were in water equal to or greater than 35 feet. This was not the case in Mossy Bay.

In June, the number and size of saugers increased with water depth (Table 17). By July, saugers were apparently abundant both inshore (0 - 20 feet of water) and offshore (40 or more feet of water) but the majority were caught in the shallower depth (Table 17). The number of net sets at the intermediate depth (21 - 29 feet) were not sufficient to provide reliable data.

The sauger catch per net was less in June than in July and the average weight at the various depths was usually greater in June than in July (Table 17). It is possible that, in June, the large spawners move from the depths (probably greater than 45 feet) to the shallows and displace the immature saugers. By July, the young saugers

apparently return to the inshore brood area that was vacated by the larger saugers. The data would indicate that this shift occurs even though the inshore areas are not utilized significantly by the spawning saugers.

Exploitation of "north-end" saugers

Some thought has been given to developing a sauger fishery in the north end of Lake Winnipeg. Such a proposal should not be accepted unless future research can indicate that sauger populations require further exploitation and a method can be developed to selectively harvest saugers. The basis for this conclusion is as follows:

1. The reproductive potential of any population is dependent, in part, on the number of mature females in that population. Considering this in conjunction with Table 18, it would be desirable to maintain at least five year classes of saugers in the fishery. Using July values, five year old female saugers from Mossy Bay would probably equal or exceed 1.06 pounds (Table 20) and fish of this size would most appropriately be caught in 3 inch mesh (Table 11). Walleyes and whitefish from 3 inch mesh would average 1.04 pounds and 1.39 pounds, respectively (Table 11). This would correspond to a three year old walleye and approximately a 3.5 year old whitefish (Tables 12 and 19). This would mean exploiting walleye and whitefish populations that were at a maximum, respectively, 40% and 50% mature in July (Table 18). These two species are too valuable and too scarce to withstand exploitation of this type.

2. The "north-end" sauger population is probably receiving considerable exploitation. Substantial numbers of saugers are taken annually by trap net and the 5 inch whitefish fishery. Also, a large part of the fall fishery depends upon north end production. Furthermore, an unexploited population is characterized by a large number of year classes. This is not the case with this fishery. Earlier, the theoretical longevity of these saugers was calculated at 15 years, or more, while the oldest age group represented in our samples was 6+.

3. There was little indication that inshore sauger populations in the north end are as enormous or widespread as first assumed. Experimental sauger catches from 400 yards of graded mesh sizes have ranged from 0 to 196 fish. In June and July of 1967, 30 experimental net sets involving 11,000 yards of net produced only 967 saugers.

Mossy Bay experimental sampling in July of 1968 indicated that only a few saugers were available. Two complete experimental gangs set in the Warrens Landing and Eagle Island areas produced only 33 small saugers (16.0% of the overall catch).

In the fall of 1968, an 8-foot trap net and 2 gill nets, each 100 yards in length were used in the Mossy Bay area as a means of locating and capturing saugers for tagging purposes. Between August 5 and August 22, 1968, only 13 taggable saugers were caught (Howard, 1969).

Although fish growth is dependent on environmental and genetic factors, fish populations often demonstrate an inverse density dependent growth rate. The fact that a group of large saugers apparently exist

in this lake would indicate that sauger density is not sufficiently high to be detrimental to growth.

4. Our results have not indicated a means by which saugers could be selectively harvested in the north end of this lake.

5. Further research is required; especially in deep water and at different seasons. Areas outside Mossy Bay have not been sufficiently tested. All experimental netting was conducted within 8 miles of shore as it was felt, initially, that the littoral areas would be most productive. Also, open water fishing on Lake Winnipeg is difficult and hazardous and nets set away from shore are hard to locate. Winter fishing could alleviate some of these problems and also provide data on sauger availability, size and distribution in deep water. It would also provide an opportunity to study the feeding behaviour of saugers in deep water and thus provide an estimate of sauger - whitefish interaction in a different season and environment.

If future studies could indicate a prevalence of deep water saugers and that other commercially important species are not being adversely affected by their presence, this could be a valuable reproducing stock that would assure a sustained sauger fishery which should not be exploited excessively.

Further sauger tagging should be attempted in the Mossy Bay area. It should be attempted while spawning is in progress and while saugers are more abundant in June and July.

Fish tend to mature at a certain size rather than a certain age with faster growing fish maturing earlier (LeCren, 1965). A faster growing fish is desirable in a commercial fishery and such a trait is apparent in our June results. This stock may not be totally isolated and is possibly providing a substantial poundage to the present sauger fishery. A large number of large saugers were collected in the fall commercial sampling in the Channel area in 1967. Due to their heavy pigmentation, they appeared quite dark especially in the dorsal region. Figure 7 indicates that average sauger size was greater in the 1967 fall samples than in the 1966 fall samples. The slopes between ages in the fall 1967 sample closely parallel those indicated for saugers taken in the June,1967 experimental nets. These could be one and the same group of fish.

SUMMARY

1. In the summer of 1967, experimental seining and netting were conducted in the north basin of Lake Winnipeg. The study was undertaken in an effort to determine whether a strong predator-prey relationship exists between saugers and young whitefish and to learn more about the population structure and life history of the sauger - especially in Mossy Bay. The report also includes comparisons of pertinent data collected between 1963 and 1966.

2. A hoop seine, 48 inches in diameter and equipped with a 12 foot long bobbinet bag was constructed and employed in an effort to locate young whitefish. Initially, it was hoped that whitefish fry would be located by seine and gill nets could then be set in their midst. The gill net samples collected in this manner were subjected to stomach analysis and general sampling techniques.

3. In June, young whitefish were located in warm protected bays close to the fish hatchery at Dauphin River and close to natural whitefish spawning grounds on the east shore of Lake Winnipeg. By July, the whitefish had dispersed and could not be located by seining or gut sampling all piscivores taken in experimental nets. Only one whitefish was positively identified from the stomach of a sauger following thirty net sets involving 11,000 yards of net.

4. In early summer, young whitefish could be found in some waters that provide temperatures ranging between 55^{o} and 65^{o} F.

5. In June, the feeding of all fish species, except coregonids, was reduced; possibly because most other species were still spawning. In June, minnows and trout-perch were the dominant food items of those saugers that were feeding. By July, the rate of feeding had generally increased and saugers were utilizing a large number of mayfly larvae as well as trout-perch and minnows.

6. An active predator-prey relationship between saugers and young whitefish could not be demonstrated in the early summer months and in the areas tested. Research of this type should be continued in different areas, different seasons and different times of the day. The feeding behavior of the common terns should also be investigated where their distribution coincides with the presence of young whitefish.

7. Highly significant differences in ageing were noted in a comparative test of two scale readers. This test involved the reading of sauger scales and it is recommended that one reader should continually read the scales from a certain species of fish.

8. Saugers caught in July were significantly smaller in size, younger in age, less mature and more abundant than those caught in June. It was concluded that either the faster growing and maturing saugers were sampled in June or that two different populations of saugers exist.

in the north basin. It is possible that a spatial separation and shift between younger and older sauger populations occurred in the inshore areas of Mossy Bay between June and July.

9. The male to female ratio of saugers was approximately 1:1.3 but it was difficult to determine the sex of saugers younger than 2+. Male saugers were smaller but matured earlier than females of a given age.

10. Only 77 walleyes were captured in experimental nets in 1967. They were most frequently caught in 3 inch mesh. A similar number of walleyes were feeding in both June and July with fish being the dominant food item.

11. Only 99 whitefish were taken in experimental nets in 1967. They were caught most frequently in 4 1/4 inch mesh nets. In many parts of the north basin, whitefish were taken commercially at inshore locations and this could be related to a coincident abundance of amphipods. In July, water temperatures continued to rise and whitefish moved to deeper water where the dominant food items became snails and clams.

12. The length-age regressions for June and July caught saugers can be described by the equations:

$y = 6.36 + 1.693\ (x)$ and $y = 5.17 + 1.612\ (x)$ respectively.

Saugers caught in June were significantly larger than those caught in July. A Walford plot indicated that the growth potential

was greater for saugers caught in June than for saugers caught in July.

13. There is evidence that some sauger age groups sampled in July, 1963, were similar to saugers sampled in June, 1967. This adds support to the contention that the north end saugers are represented by more than one population.

14. Mossy Bay saugers were generally distributed close to the lake bottom. In June, spawning saugers appear to enter the shallows from depths greater than 45 feet. Few small saugers were found inshore in June but their numbers increased markedly in July. A populations shift between younger and older age groups might occur between June and July.

15. A sauger fishery in the north end of Lake Winnipeg should not be considered at this time unless future research indicates that sauger populations require further exploitation and a method can be developed to selectively capture saugers. The use of small mesh nets would decimate the remaining walleye and whitefish stocks. Sauger abundance probably fluctuates and is not as enormous as first assumed. The "north-end" saugers are probably receiving considerable pressure from trap nets and the gill net fishery in the north end and the fall fishery of the Channel area. Further research is required in different areas and seasons. Sauger tagging should be continued.

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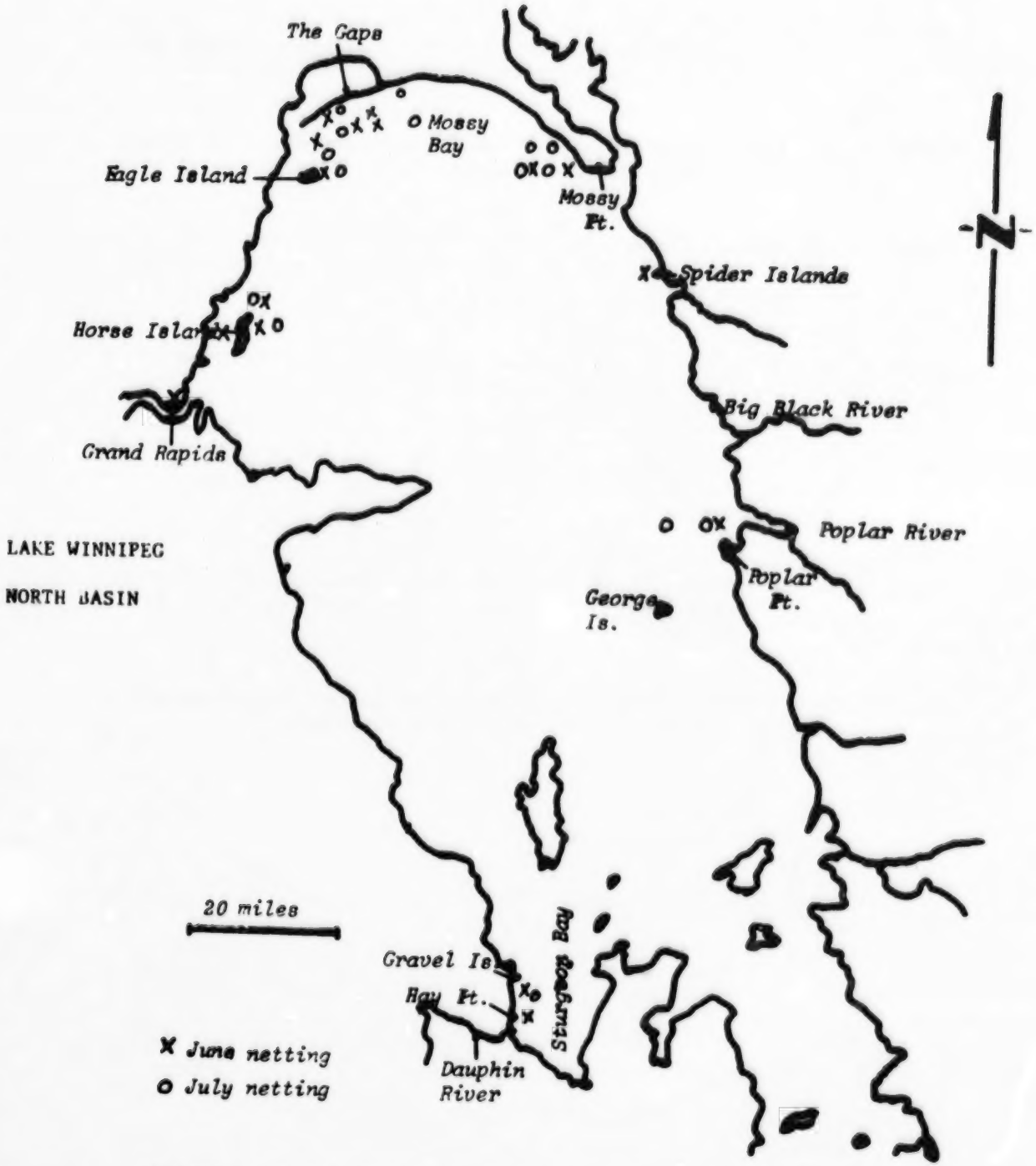

FIGURE 1 Experimental netting areas, June and July, 1967.

FIGURE 2. Growth relationships Mossy Bay sauger, June and July, 1967.

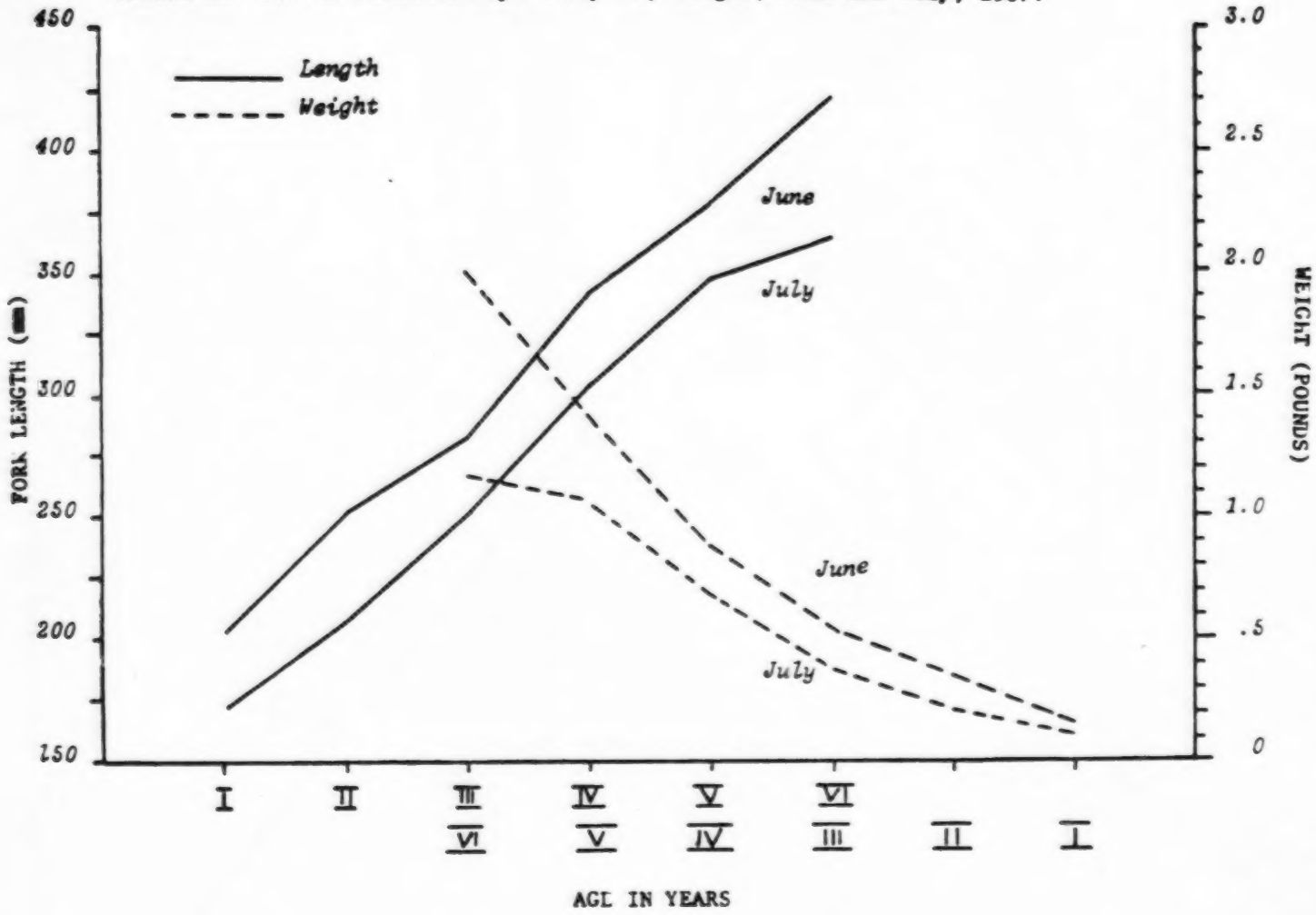

FIGURE 3. Length - age regressions, Mossy Bay sauger, June - 1967

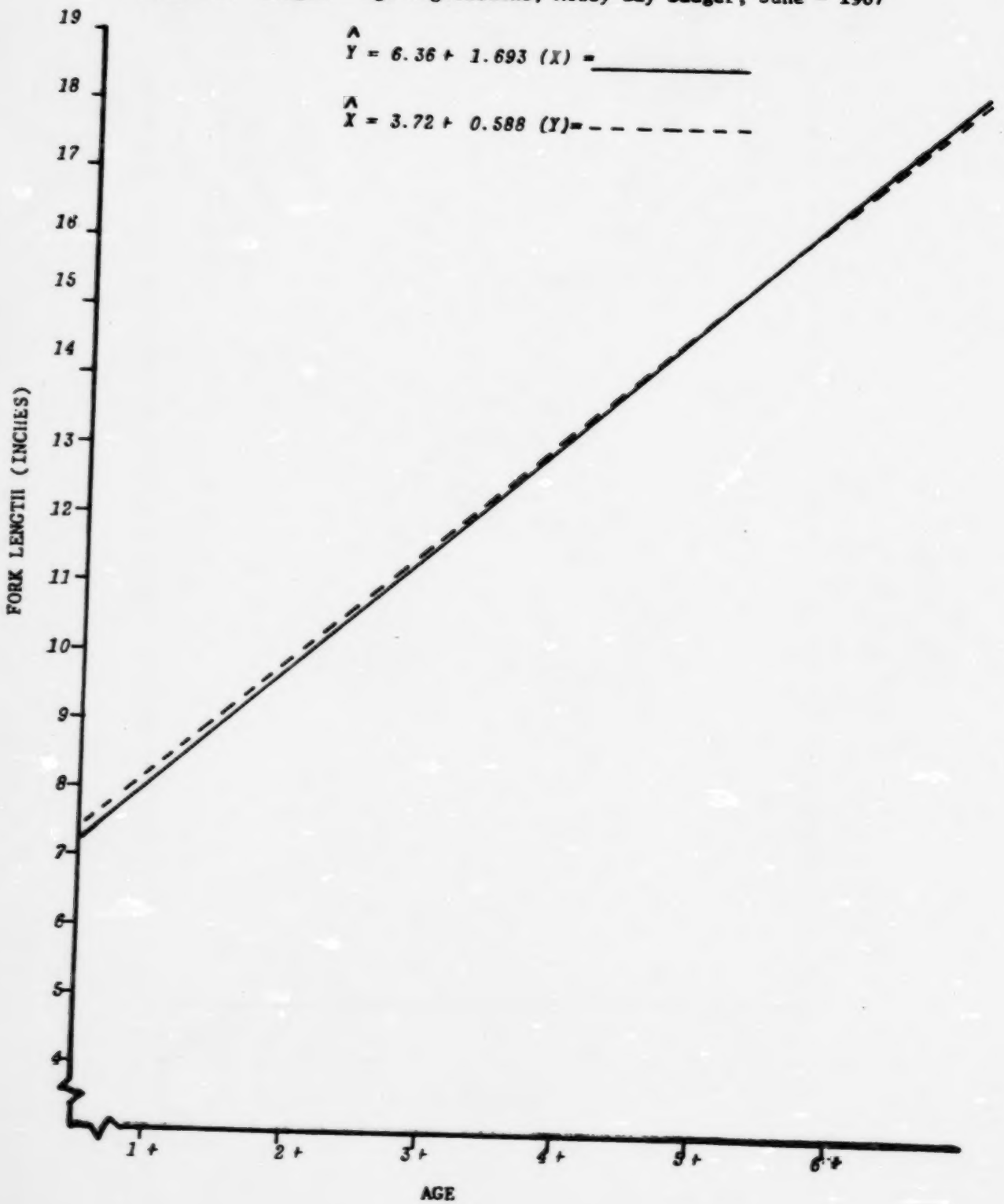

FIGURE 4. Length - age regressions, Mossy Bay sauger, July - 1967

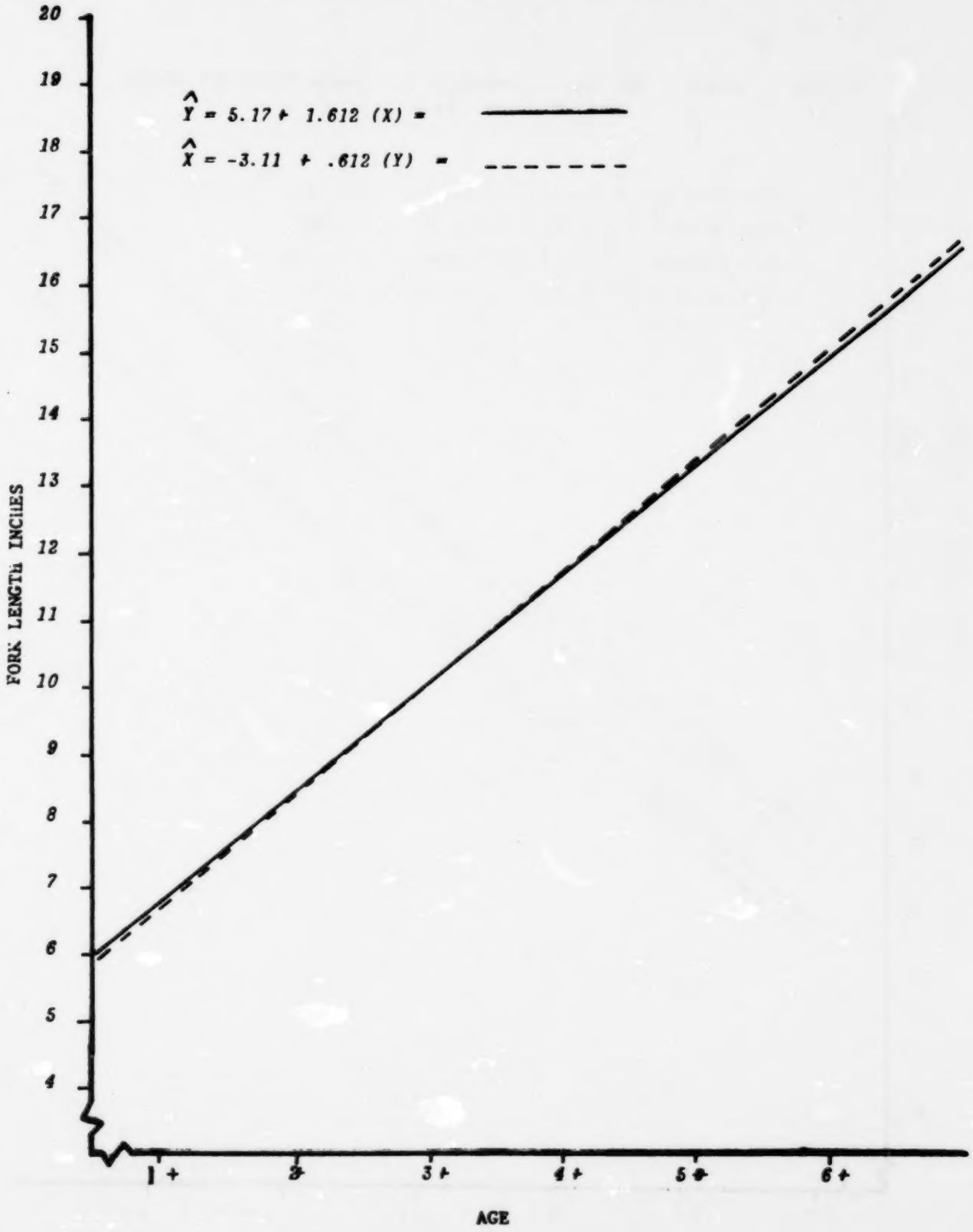

FIGURE 5. Length - age regressions male and female Mossy Bay sauger, June and July, 1967.

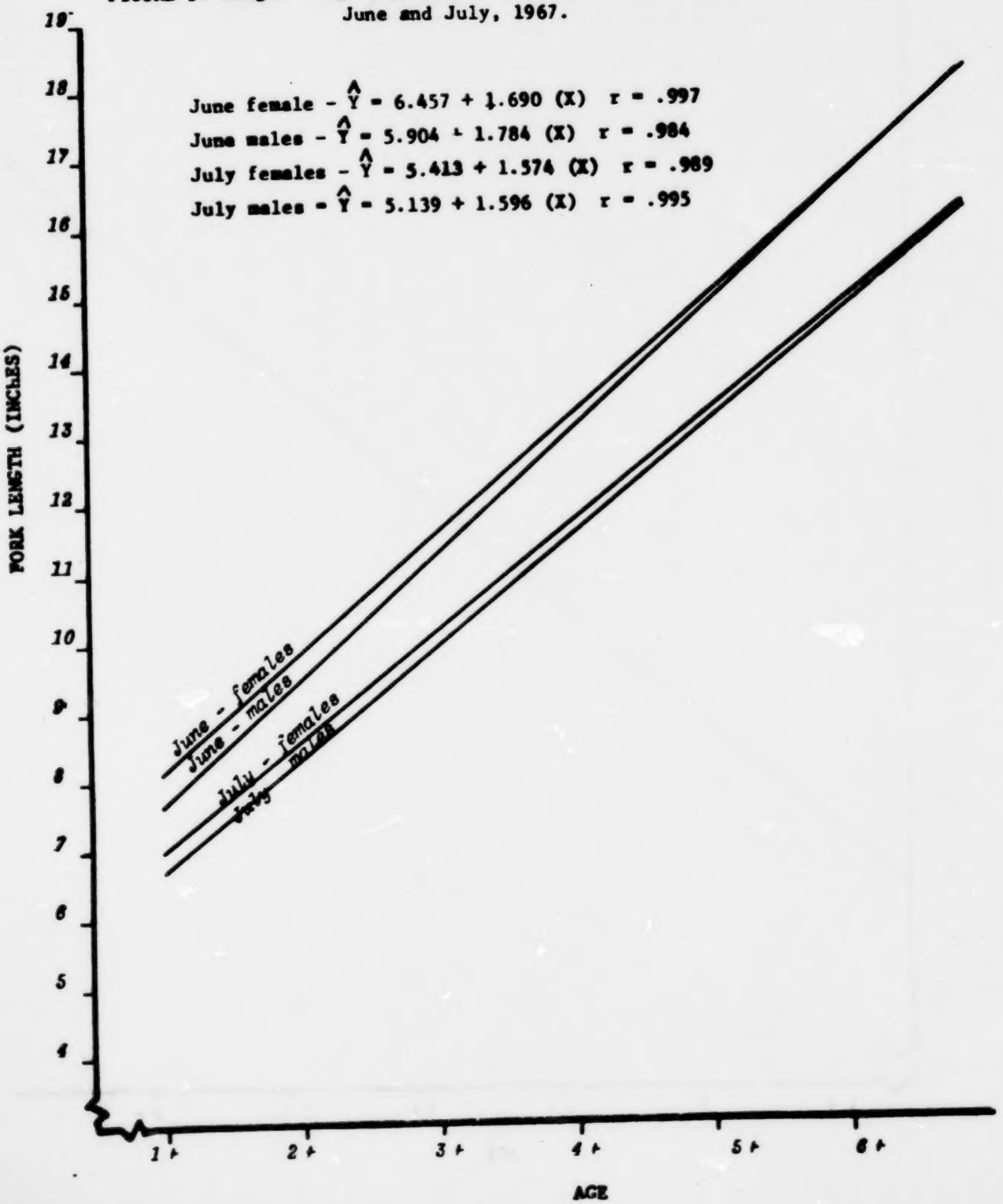

FIGURE 6. Walford plots, Mossy Bay sauger, June and July, 1967.

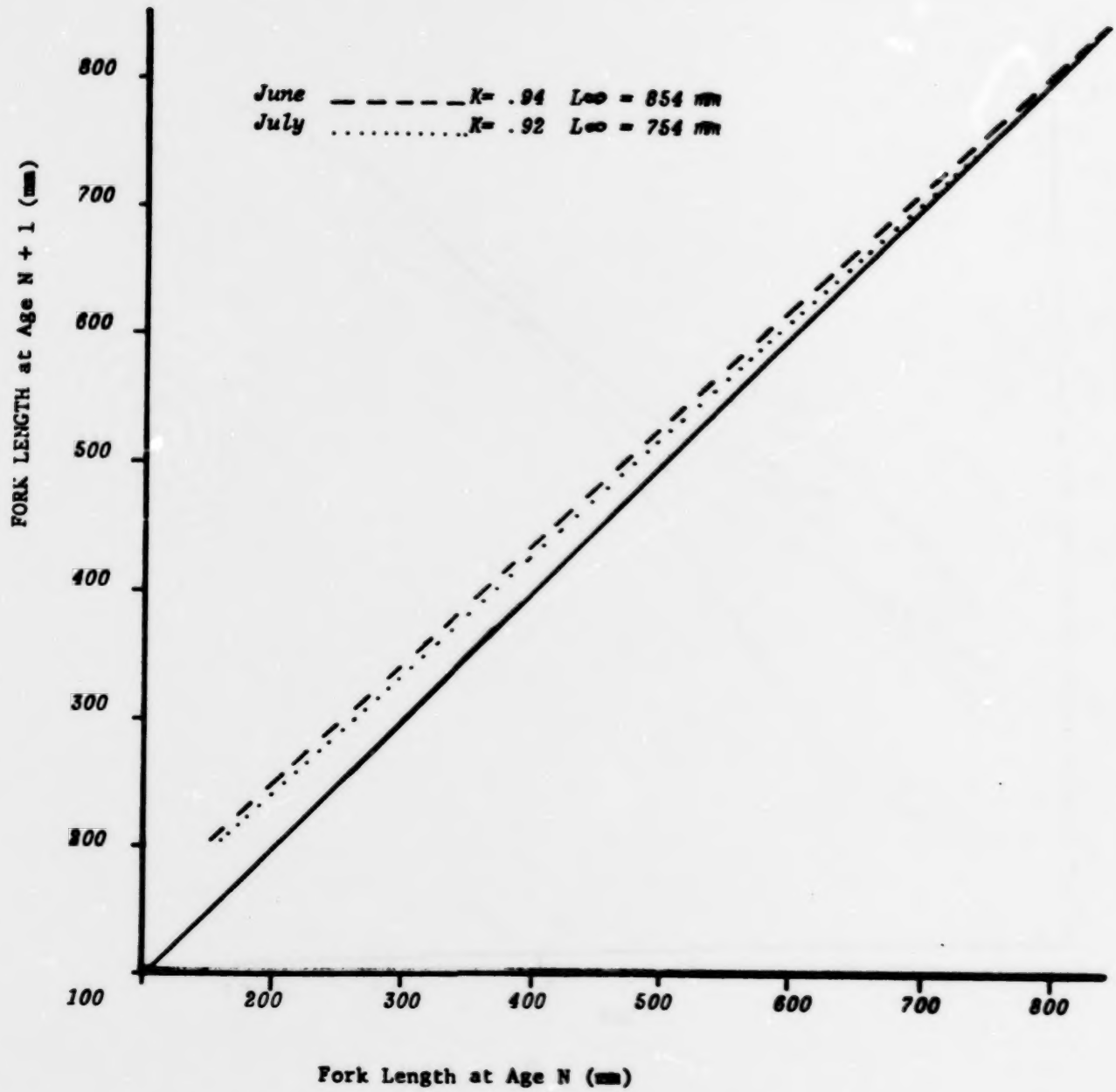

FIGURE 7. Length - age relationship, Matheson Island (M.I.) and Mossy Bay (M.B.)

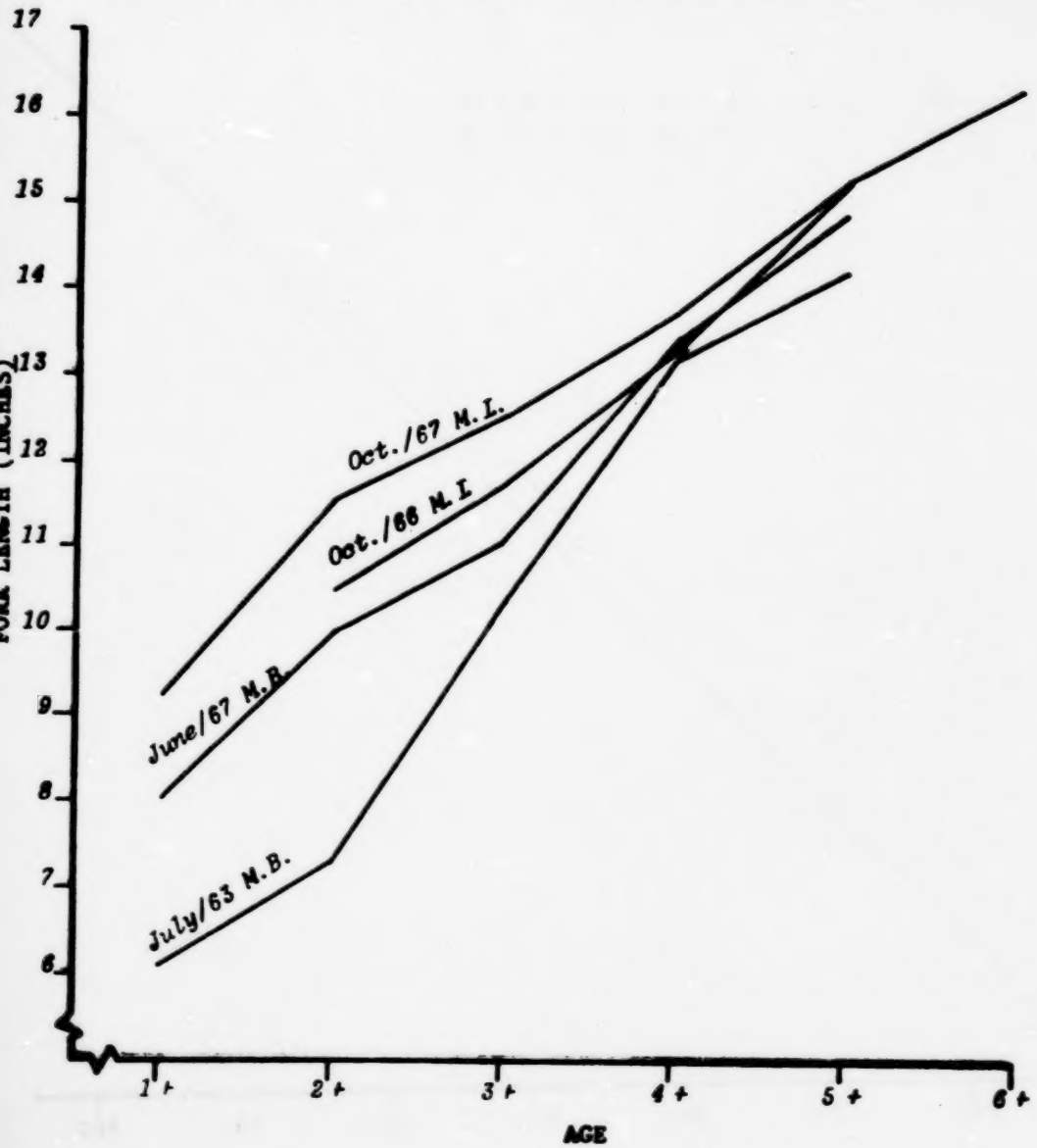

Table 1. Typical catch resulting from seine hauls, Sturgeon Bay, July, 1967.

Haul No.	Type	Seine settings		R.P.M.	Time (minutes)	Catch
		Top	sides			
1 (in reverse) gear	Bottom (15-25 feet)	0	4	1200	10	Bottom fauna, plants
2 (in reverse) gear	Above bottom	8	0	1200	15	31 perch cladocerans
3 (forward gear)	Surface	14	0	1000	20	72 perch 11 shiners 4 sticklebacks 2 darters cladocerans
4 (forward gear)	Approx. 8 feet below surface	6	0	800	20	14 perch 2 shiners cladocerans

Table 2. Catch frequency per 100 yards of experimental gillnet, all north end areas, 1967

SPECIES	Mesh Size (inches)					
	1 1/2	2	3	3 3/4	4 1/4	5
Sauger	15.45	20.07	15.70	6.00	2.89	3.27
Whitefish	1.10	0.57	1.11	1.29	1.25	0.27
Walleye	0.62	1.21	1.85	1.07	0.36	0.04
Tullibee	78.83	32.43	9.63	1.35	0.39	0.27
Burbot	0.21	0.14	0.30	0.43	1.07	0.31
Pike	1.65	2.57	2.74	0.93	0.32	0.08
White sucker	0.07	0.14	4.00	4.64	5.53	0.46
Sturgeon sucker	0.14	0.21	3.78	3.50	2.21	0.27
Northern redhorse	-	0.07	0.07	-	0.04	-
Perch	71.59	45.78	22.52	1.64	0.32	0.04
Sheepshead	-	-	0.15	0.07	0.18	0.19
Trout - perch	0.62	-	-	-	-	0.04
Flathead chub	4.55	1.71	1.11	-	-	-

Table 3. Experimental gillnet catches of saugers from various areas of the north basin, Lake Winnipeg, June, July and total, 1967. Weight in pounds.

	Mesh size (inches)						
	1 1/2	2	3	3 3/4	4 1/4	5	Total
June							
No. of fish	25	68	121	60	44	12	330
Yards	700	700	650	700	1400	1200	5350
No./100 yds.	3.57	9.71	18.61	8.57	3.14	1.00	6.17
Total wt.	7.31	41.22	113.82	80.47	60.63	11.83	315.28
Av. wt.	0.29	0.61	0.94	1.34	1.38	0.98	0.95
Wt./100 yds.	1.04	5.89	17.51	11.50	4.33	0.99	5.89
Av. age ± SE	2.64 ± 0.18	3.50 + 0.10	3.95 ± 0.06	4.35 ± 0.07	3.98 ± 0.18	3.50 ± 0.51	3.82 ± 0.05
July							
No. of fish	199	212	92	24	37	73	637
Yards	750	700	700	700	1400	1400	5650
No./100 yds.	26.53	30.29	13.14	3.43	2.64	5.21	11.27
Total wt.	64.16	81.68	79.28	23.72	36.93	34.38	320.15
Av. wt.	0.32	0.38	0.86	0.99	1.00	0.47	0.50
Wt./100 yds.	8.55	11.67	11.32	3.39	2.64	2.45	5.67
Av. age ± SE	2.60 ± 0.07	3.38 ± 0.06	4.11 ± 0.11	3.54 ± 0.23	3.27 ± 0.17	3.18 ± 0.11	3.21 ± 0.01
Total							
No. of fish	224	280	213	84	81	85	967
Yards	1450	1400	1350	1400	2800	2600	11,000
No./100 yds.	15.45	20.0	15.78	6.00	2.89	3.27	8.79
Total wt.	71.47	122.90	193.10	104.19	97.56	46.21	635.43
Av. wt.	0.32	0.44	0.91	1.24	1.20	0.54	0.66
Wt./100 yds.	4.93	8.78	14.30	7.44	3.48	1.78	5.78
Av. age ± SE	2.59 ± 0.18	3.30 ± 0.15	4.04 ± 0.07	4.39 ± 0.09	3.95 ± 0.15	3.21 ± 0.12	3.45 ± 0.11

Table 4. Experimental gillnet catches of walleyes from various areas of the north basin, Lake Winnipeg June, July and total, 1967. Weight in pounds.

	Mesh size (inches)						
	1 1/2	2	3	3 3/4	4 1/4	5	Total
June							
No. of fish	5	10	13	11	7	0	46
Yards	700	700	650	700	1400	1200	5350
No./100 yds.	0.71	1.43	2.00	1.57	0.5	0	0.86
Total wt.	3.03	8.43	13.65	13.69	13.69	0	52.49
Av. wt.	0.61	0.84	1.05	1.24	1.95	0	1.14
Wt./100 yds.	0.43	1.20	2.10	1.96	0.98	0	0.98
Av. age ± SE	2.60 ± 0.40	3.45 ± 0.31	3.75 ± 0.35	3.91 ± 0.28	4.14 ± 0.46	0	3.65 ± 0.16
July							
No. of fish	4	7	12	4	3	1	31
Yards	750	700	700	700	1300	1400	5650
No./100 yds.	0.53	1.00	1.71	0.57	0.21	0.07	0.55
Total wt.	3.00	3.88	12.97	7.13	4.69	2.94	34.63
Av.wt.	0.75	0.55	1.08	1.78	1.56	2.94	1.12
Wt./100 yds.	0.40	0.55	1.85	1.02	0.33	0.21	0.61
Av.age ± SE	2.25 ± 0.62	2.28 ± 0.29	3.33 ± 0.11	3.25 ± 0.62	4.33 ± 0.66	5.0 ± 0	3.10 ± 0.23
Total							
No. of fish	9	17	25	15	10	1	77
Yards	1450	1400	1350	1400	2800	2600	11,000
No./100 yds.	0.62	1.21	1.85	1.07	0.36	0.04	0.70
Total wt.	6.06	12.31	26.62	20.81	18.38	2.94	86.51
Av. wt.	0.67	0.72	1.06	1.39	1.84	2.94	1.12
Wt./100 yds.	0.42	0.88	1.97	1.49	0.66	0.11	0.79
Av. age ± SE	2.44 ± 0.33	3.0 ± 0.25	3.54 ± 0.25	3.73 ± 0.27	4.2 ± 0.37	5.0 ± 0	3.43 ± 0.14

Table 5. Experimental gillnet catches of whitefish from various areas of the north basin, Lake Winnipeg, June, July and total, 1967. Weight in pounds

	Mesh size (inches)						
	1 1/2	2	3	3 3/4	4 1/4	5	Total
June							
No. of fish	7	7	9	13	13	4	53
Yards	700	700	650	700	1400	1200	5350
No./100 yds.	1.00	1.00	1.38	1.86	0.93	0.33	0.99
Total wt.	0.63	1.69	9.12	22.81	19.44	9.44	63.12
Av.wt.	0.09	0.24	1.01	1.75	1.49	2.36	1.19
Wt./100 yds.	10.09	0.24	1.40	3.26	1.39	0.79	1.18
Av. age ± SE	1 ± 0	1.71 ± 0.18	3.44 ± 0.24	4.00 ± 0.23	3.69 ± 0.13	4.50 ± 0.29	3.17 ± 0.18
July							
No. of fish	9	1	6	5	22	3	46
Yards	750	700	700	700	1400	1400	5650
No./100 yds.	1.20	0.14	0.86	0.71	1.57	0.21	0.81
Total wt.	0.91	0.31	8.34	5.96	39.84	5.09	57.46
Av. wt.	0.10	0.31	1.39	1.19	1.81	1.70	1.25
Wt./100 yds.	0.12	0.04	1.19	0.85	2.84	0.36	1.02
Av. age ± SE	1.0 ± 0	2.0 ± 0	3.67 ± 0.33	3.80 ± 0.37	3.95 ± 0.14	3.67 ± 0.33	3.26 ± 0.19
Total							
No. of fish	16	8	15	18	35	7	99
Yards	1450	1400	1350	1400	2800	2600	11,000
No./100 yds.	1.10	0.57	1.11	1.29	1.25	0.27	0.90
Total wt.	1.53	2.00	17.47	28.77	59.28	14.53	123.58
Av. wt.	0.09	0.25	1.16	1.60	1.69	2.07	1.25
Wt./100 yds.	0.10	0.14	1.29	2.06	2.12	0.56	1.12
Av. age ± SE	1.0 ± 0	1.75 ± 0.16	3.53 ± 0.19	3.94 ± 0.19	3.86 ± 0.10	4.14 ± 0.26	3.21 ± 0.13

Table 6. Sauger growth relationships and stage of maturity based on experimental gill net catches from various areas of the north basin, Lake Winnipeg, June and July, 1967. Percent frequencies are given in brackets.

		Age					
		1 +	2+	3+	4+	5+	6+
Frequency (%)	June	9 (2.7)	22 (6.7)	60 (18.2)	166 (50.3)	71 (21.5)	2 (0.6)
(%)	July	26 (4.1)	133 (20.9)	250 (39.3)	158 (24.8)	53 (8.3)	16 (2.5)
Fork length (inches ± SE)	June	7.17 ± .58	9.81 ± .13	11.00 ± .25	13.44 ± .06	14.73 ± .17	16.45 ± .22
	July	7.07 ± .17	8.34 ± .12	10.11 ± .08	11.88 ± .13	13.67 ± .25	14.41 ± .29
Round weight (lbs. ± SE)	June	.13 ± .00	.39 ± .04	.53 ± .04	.90 ± .04	1.41 ± .05	2.03 ± .00
	July	.12 ± .00	.23 ± .00	.40 ± .00	.68 ± .00	1.06 ± .05	1.16 ± .07
Percent Mature	June						
	-males	-	70.6	84.2	98.8	100.0	
	-females	-	-	36.6	54.8	81.1	50.0
	July						
	- males	10.0	23.6	56.7	85.5	93.7	100.0
	- females	0.0	5.3	30.1	51.0	62.2	75.0

Table 7. Growth, maturity and feeding behavior of saugers caught in all experimental nets, June, July and total, 1967. Major food items are coded (1=fish remains and unidentified minnows; 2=mayfly larvae; 3=trout-perch; 4=tullibee (and whitefish); 5-chub; 6=chironomids; 7=sunfish; 8=perch; 9=others) in order of decreasing frequency.

	Mesh size (inches)						
	1 1/2	2	3	3 3/4	4 1/4	5	Total
June							
No. of fish	25	68	121	60	44	12	330
Av.wt. (lbs.)	0.29	0.61	0.94	1.34	1.38	0.98	0.95
Av. length (in.)	9.55	11.37	13.13	14.46	14.38	12.21	12.99
No. mature-males	6	18	56	39	13	2	134
-females	1	20	43	15	19	3	101
% mature-males	33.3	69.2	98.2	100.0	100.0	100.0	92.4
-females	6.25	46.5	67.2	71.4	65.5	37.5	55.8
Male/female ratio	1.12	0.60	0.89	1.86	0.45	0.25	0.80
% feeding	20.0	29.0	19.8	8.3	9.1	16.7	18.1
Major food items	1,6	1,2,9	1,6	1	1,6	1	
July							
No. of fish	199	212	92	24	37	73	637
Av. wt.(lbs.)	0.32	0.38	0.86	0.99	1.00	0.47	0.50
Av. length (in.)	8.80	10.49	12.93	12.05	10.98	10.44	10.39
No. mature-males	40	60	18	3	11	21	153
-females	12	44	40	8	9	12	125
% mature-males	41.67	66.67	81.82	60.00	55.00	63.64	57.36
-females	12.24	36.36	54.70	42.10	56.25	29.27	35.21
Male/female ratio	0.98	0.74	0.33	0.26	1.25	0.80	0.75
% feeding	46.7	38.7	43.5	45.8	38.9	47.3	43.2
Major food items	1,5,6 2,4	2,1,3 5	3,1,4 5	4,1	1,5	1,4 3,5	
Total							
No. of fish	224	281	212	84	81	85	967
Av.wt.(lbs)	0.32	0.42	0.90	1.24	1.20	0.54	0.65
Av.length(in.)	8.89	10.66	13.11	13.96	12.85	10.69	11.28
No.mature-males	46	78	74	42	24	23	287
-females	13	64	83	23	28	15	226
% mature-males	44.23	67.24	93.67	95.45	72.73	65.71	69.66
-females	11.40	39.02	63.36	57.50	62.22	30.61	42.16
Male/female ratio	0.91	0.71	0.60	1.10	0.73	0.71	0.77
% feeding	43.7	36.3	30.0	19.0	22.5	43.0	34.6

Table 8. Growth, maturity and feeding behavior of walleyes caught in all experimental nets, June, July and total, 1967. Major food items are coded as in Table 7.

	Mesh size (inches)						
	1 1/2	2	3	3 3/4	4 1/4	5	Total
June							
No. of fish	5	10	13	11	7	-	46
Av. wt. (lbs.)	0.61	0.84	1.05	1.24	1.95	-	0.86
Av. length (in.)	9.88	12.31	13.22	15.08	16.66	-	13.38
No. mature-males	1	0	1	2	1	-	5
-females	0	0	0	1	1	-	2
% mature-males	100.0	0	20.0	40.0	50.0	-	35.71
-females	0	0	0	14.3	20.0	-	6.25
Male/female ratio	.33	.11	.62	.71	.40	-	.44
% feeding	40.00	70.00	53.85	33.33	71.43	-	53.19
Major food items	1,2	1	1	1	1	-	
July							
No. of fish	4	7	12	4	3	1	31
Av.wt (lbs.)	0.75	0.55	1.08	1.78	1.56	2.94	1.12
Av. length (in.)	11.05	10.80	13.93	15.95	15.13	18.40	13.37
No. mature-males	0	0	1	0	0	1	2
-females	1	0	1	3	2	0	7
% mature-males	0	0	25.0	0	0	100.0	16.7
-females	100.0	0	12.5	100.0	66.7	0	36.8
Male/female ratio	3.0	0.75	0.5	0.33	0	1.0	0.63
% feeding	75.0	28.6	75.0	25.0	33.3	100.0	54.8
Major food items	2,4	1	1,2 4	4	1	1	
Total							
No. of fish	9	17	25	15	10	1	77
Av. wt. (lbs.)	0.67	0.72	1.06	1.39	1.84	2.94	1.12
Av. length (in.)	9.85	11.69	13.61	14.35	16.20	18.40	13.38
No. mature-males	1	0	2	2	1	1	7
-females	1	0	1	4	3	0	9
% mature-males	25.0	0	22.2	33.3	50.0	100.0	26.92
-females	25.0	0	6.2	40.0	37.5	0	17.64
Male/female ratio	1.0	0.31	0.56	0.60	0.25	1.0	0.51
% feeding	55.6	52.9	64.0	31.2	60.0	100.0	53.8

Table 9. Growth, maturity and feeding behavior of whitefish caught in all experimental nets, June, July and total, 1967. Major food items are coded (1=amphipods; 2=snails and clams; 3=chironomids; 4=mayfly larvae; 5=caddisfly larvae) in order of decreasing frequency.

	Mesh size (inches)						
	1 1/2	2	3	3 3/4	4 1/4	5	Total
June							
No. of fish	7	7	9	13	13	4	53
Av. wt. (lbs.)	0.09	0.24	1.01	1.75	1.49	2.36	1.19
Av. length (in.)	5.52	8.05	12.30	14.48	13.60	15.62	11.95
No. mature-males	0	0	2	2	1	2	7
-females	0	0	1	4	5	2	12
% mature-males	0	0	28.6	40.0	33.3	100.0	29.2
-females	0	0	50.0	50.0	50.0	100.0	54.5
Male/female ratio	1.09	0	2.5	3.5	0.62	0.62	1.09
% feeding	85.7	100.0	66.7	76.9	46.1	75.0	71.7
Major food items	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,4	
July							
No. of fish	9	1	6	5	22	3	46
Av. wt. (lbs.)	0.10	0.31	1.39	1.19	1.81	1.70	1.25
Av. length(in.)	5.81	9.20	13.45	13.68	14.50	14.47	12.46
No. mature-males	0	0	1	1	11	1	14
-females	0	-	1	2	5	1	9
% mature-males	0	0	20.0	50.0	78.6	50.0	56.0
-females	0	-	100.0	66.7	62.5	100.0	64.29
Male/female ratio	1.0	0	5.0	0.67	1.75	2.0	1.78
% feeding	77.8	100.0	33.3	60.0	77.3	33.3	67.4
Major food items	2,5,4,3,1	5,3	4,5	2,4	2,5,4,3,1	2,4,3,1	
Total							
No. of fish	16	8	15	18	35	7	99
Av. wt. (lbs.)	0.09	0.25	1.16	1.60	1.69	2.07	1.25
Av. length (in.)	5.68	8.20	12.76	14.26	14.17	15.13	12.19
No. mature-males	0	0	3	3	12	3	21
-females	0	0	2	6	10	3	21
% mature-males	0	0	25.0	42.8	63.2	75.0	42.9
-females	0	0	66.7	54.5	62.5	100.0	58.3
Male/female ratio	1.0	3.0	4.0	0.64	1.19	1.33	1.36
% feeding	81.2	100.0	53.3	72.2	65.7	57.1	69.7

Table 10. Experimental gillnet catches of saugers, walleyes and whitefish by mesh size, Mossy Bay, June 1967. Weight in pounds.

	Mesh size (inches)						
	1 1/2	2	3	3 3/4	4 1/4	5	Total
SAUGER							
No. of fish	20	58	106	55	29	6	274
Yards	400	400	400	400	800	800	3200
No./100 yds.	5.00	14.50	26.50	13.75	3.62	0.75	8.56
Total wt.	5.66	34.22	97.76	72.76	46.58	9.43	266.07
Av. wt.	0.28	0.59	0.92	1.32	1.61	1.57	0.97
Wt./100 yds.	1.41	8.56	24.44	18.19	5.82	1.18	8.31
Av. age ± SE	2.60 ± .21	3.50 ± .11	3.92 ± .06	4.30 ± .07	4.48 ± .14	4.67 ± .61	3.89 ± .05
WALLEYE							
No. of fish	3	2	6	5	1	0	17
Yards	400	400	400	400	800	800	3200
No./100 yds.	0.75	0.50	1.50	1.25	0.12	-	0.53
Total wt.	2.12	1.84	5.19	6.06	2.19	-	17.40
Av. wt.	0.71	0.92	0.86	1.21	2.19	-	1.02
Wt./100 yds.	0.53	0.46	1.30	1.51	0.27	-	0.54
Av. age ± SE	3.0 ± .00	4.0 ± .00	3.83 ± 0.31	3.80 ± .58	5.0 ± .00	-	3.76 ± .24
WHITEFISH							
No. of fish	1	1	4	10	8	1	25
Yards	400	400	400	400	800	800	3200
No./100 yds.	0.25	0.25	1.00	2.50	1.00	0.12	0.78
Total wt.	0.09	0.25	3.72	16.93	12.63	2.06	35.68
Av. wt.	0.09	0.25	0.93	1.69	1.58	2.06	1.43
Wt./100 yds.	0.02	0.06	0.93	4.23	1.58	0.26	1.11
Av. age ± SE	1 ± .00	2 ± .00	3.25 ± .48	3.90 ± .18	3.75 ± .16	4.0 ± .00	3.56 ± .17

Table 11. Experimental gillnet catches of saugers, walleyes and whitefish by mesh size, Mossy Bay, July, 1967. Weight in pounds.

	Mesh size (inches)						
	1 1/2	2	3	3 3/4	4 1/4	5	Total
SAUGER							
No. of fish	132	146	81	22	31	67	479
Yards	500	500	500	500	1000	1000	4000
No./100 yds.	26.40	29.20	16.20	4.40	3.10	6.70	11.97
Total wt.	38.10	68.82	73.93	16.35	19.03	31.24	247.47
Av. wt.	0.29	0.47	0.91	0.74	0.61	0.47	0.52
Wt./100 yds.	7.62	13.76	14.79	3.27	1.90	3.12	6.19
Av. age ± SE	2.64 ± .09	3.44 ± .07	4.26 ± .12	3.45 ± .24	2.93 ± .31	3.16 ± .10	3.29 ± .05
WALLEYE							
No. of fish	2	6	10	4	2	1	25
Yards	500	500	500	500	1000	1000	4000
No./100 yds.	0.40	1.20	2.00	0.80	0.20	0.10	0.62
Total wt.	2.56	2.72	10.38	7.21	2.97	2.94	28.78
Av. wt.	1.28	0.45	1.04	1.80	1.48	2.94	1.15
Wt./100 yds.	0.51	0.54	2.08	1.44	0.30	0.29	0.72
Av. age ± SE	3.0 ± .00	2.17 ± .31	3.30 ± .37	3.25 ± .63	4.00 ± .00	5.00 ± .00	3.12 ± .24
WHITEFISH							
No. of fish	9	1	6	5	22	3	46
Yards	500	500	500	500	1000	1000	4000
No./100 yds.	1.80	0.20	1.20	1.00	2.20	0.30	1.15
Total wt.	0.87	0.31	8.33	7.32	36.62	5.09	58.54
Av. wt.	0.10	0.31	1.39	1.46	1.66	1.70	1.27
Wt./100 yds.	0.17	0.06	1.66	1.46	3.66	0.51	1.46
Av. age ± SE	1.00 ± .00	2.0 ± .00	3.67 ± .03	3.80 ± .38	3.95 ± .14	3.67 ± .34	3.26 ± .19

Table 12. Age frequencies and mean weight (pounds) and length (inches) by age of Mossy Bay, saugers, walleyes and whitefish, June and July, 1967. Percent frequencies are given in brackets.

		Age						
		1+	2+	3+	4+	5+	6+	Total
				Frequencies				
SAUGER	June	4(1.5)	16(5.8)	47(17.2)	144(52.5)	61(22.3)	2(0.7)	274
	July	16(3.3)	92(19.2)	175(36.5)	132(27.6)	49(10.2)	15(3.1)	479
WALLEYE	June		2(11.8)	4(23.5)	7(41.2)	4(23.5)		17
	July	1(4.0)	8(32.0)	8(32.0)	3(12.0)	5(20.0)		25
WHITEFISH	June	1(4.0)	2(8.0)	5(20.0)	16(64.0)	1(4.0)		25
	July	9(19.6)	1(2.2)	11(23.9)	19(41.3)	6(13.0)		46
				Mean Weight (±SE)				
SAUGER	June	.16 ± .09	.35 ± .04	.53 ± .04	.87 ± .03	1.41 ± .05	2.03 ± .00	.90 ± .03
	July	.11 ± .01	.21 ± .01	.37 ± .01	.69 ± .03	1.06 ± .06	1.16 ± .08	.51 ± .02
WALLEYE	June		.75 ± .44	.70 ± .38	.98 ± .37	1.55 ± .22		1.02 ± .35
	July	.22 ± .00	.86 ± .21	1.09 ± .17	1.34 ± .50	1.79 ± .45		1.15 ± .15
WHITEFISH	June	.09 ± .00	.48 ± .24	1.30 ± .09	1.61 ± .10	2.37 ± .00		1.43 ± .11
	July	.10 ± .01	.31 ± .00	1.22 ± .09	1.63 ± .06	2.15 ± .14		1.27 ± .10
				Mean Length (±SE)				
SAUGER	June	8.02 ± .89	9.94 ± .31	11.05 ± .26	13.40 ± .13	14.85 ± .17	16.45 ± .25	12.94 ± .14
	July	6.79 ± .18	8.17 ± .16	9.87 ± .10	11.93 ± .15	13.68 ± .10	14.36 ± .09	10.53 ± .10

Table 13. Catch frequency and mean round sauger weight (pounds) by age, Mossy Bay, July 1963, 1965, 1966 and 1967. Percent frequencies are given in brackets.

	Age	Year 1963	1965	1966	1967	Total
Frequency (%)	1+	94(30.0)	48(12.3)		16(3.3)	158(12.2)
	2+	150(47.9)	206(53.0)	26(22.2)	92(19.2)	474(36.5)
	3+	52(16.6)	72(18.5)	14(12.0)	175(36.5)	313(24.1)
	4+	13(4.2)	54(13.9)	35(29.9)	132(27.6)	234(18.0)
	5+	4(1.3)	9(2.3)	31(26.5)	49(10.2)	93(7.2)
	6+			10(8.5)	15(3.1)	25(1.9)
	7+			1(0.9)		1(0.1)
	TOTAL	313	389	117	479	1298
Weight (±SE)	1+		.19 ± .01		.11 ± .01	.17 ± .03
	2+		.35 ± .01	.24 ± .01	.21 ± .01	.30 ± .01
	3+		.65 ± .01	.47 ± .02	.37 ± .01	.45 ± .01
	4+		1.06 ± .02	.71 ± .00	.69 ± .03	.79 ± .02
	5+		1.47 ± .08	1.03 ± .03	1.06 ± .06	1.09 ± .04
	6+			1.43 ± .03	1.16 ± .08	1.27 ± .06
	7+			1.69 ± .00		1.69 ± .00
	TOTAL		.50 ± .02	.73 ± .03	.51 ± .02	.54 ± .01

Table 14. Mean sauger fork length (inches ± SE) by mesh size and age, Mossy Bay, July 1963, 1965, 1966 and 1967. Sample size is given in parenthesis.

	Year				
Mesh size	1963	1965	1966	1967	Total
1 1/2		9.07 ± .42(60)	8.90 ± .24(25)	8.79 ± .16(132)	8.88 ± .11(217)
2		10.34 ± .16(100)	10.81 ± .51(25)	10.57 ± .14(146)	10.51 ± .10(271)
2 1/2		11.51 ± .18(79)	12.33 ± .26(25)		11.71 ± .15(104)
3		11.73 ± .36(32)	13.95 ± .27(31)	12.90 ± .25(81)	12.87 ± .18(144)
3 1/2		11.94 ± .48(31)	13.52 ± .87(5)		12.16 ± .45(36)
3 3/4		11.16 ± .49(22)	15.15 ± .85(2)	11.62 ± .66(22)	11.55 ± .41(46)
4		9.89 ± .33(16)	14.30 ± .66(3)		10.58 ± .48(19)
4 1/4		10.41 ± .52(20)		10.82 ± .60(31)	10.66 ± .41(51)
4 1/2		10.84 ± .55(13)	16.60 ± .00(1)		11.25 ± .65(14)
5		10.67 ± .45(16)		10.51 ± .21(67)	10.54 ± .19(83)
TOTAL		10.69 ± .20(389)	11.89 ± .24(117)	10.53 ± .11(479)	10.75 ± .07(985)
A G E					
1+	6.09 ± .09(94)	8.21 ± .08(48)		6.79 ± .18(16)	6.80 ± .10(158)
2+	7.24 ± .13(150)	9.81 ± .05(206)	8.62 ± .18(26)	8.17 ± .16(92)	8.61 ± .08(474)
3+	10.30 ± .19(52)	11.94 ± .10(72)	10.33 ± .18(14)	9.87 ± .10(175)	10.44 ± .08(313)
4+	13.15 ± .25(13)	13.78 ± .10(54)	11.86 ± .32(35)	11.93 ± .15(132)	12.42 ± .11(234)
5+	14.15 ± .57(4)	15.41 ± .24(9)	14.02 ± .18(31)	13.68 ± .10(49)	13.99 ± .16(93)
6+			15.53 ± .18(10)	14.36 ± .09(15)	14.83 ± .22(25)
7+			16.60 ± .00(1)		16.60 ± .00(1)
TOTAL	7.74 ± .13(313)	10.69 ± .00(389)	11.89 ± .24(117)	10.53 ± .11(479)	10.03 ± .00(1298)

Table 15. Mean sauger weight (pounds ± SE) by mesh size, Mossy Bay, July 1965, 1966 and 1967. Sample size is given in parenthesis.

	Year			
	1965	1966	1967	Total
Mesh size				
1 1/2	.28 ± .01(60)	.31 ± .02(25)	.29 ± .02 (132)	.29 ± .02(217)
2	.43 ± .03(100)	.56 ± .05(25)	.47 ± .02(146)	.46 ± .01(271)
2 1/2	.61 ± .03(79)	.76 ± .04(25)		.64 ± .03(104)
3	.66 ± .06(32)	1.04 ± .05(31)	.91 ± .04(81)	.88 ± .03(144)
3 1/2	.76 ± .08(31)	.98 ± .15(5)		.79 ± .07(36)
3 3/4	.61 ± .09(22)	1.37 ± .18(2)	.74 ± .12(22)	.71 ± .07(46)
4	.37 ± .04(16)	1.23 ± .09(3)		.51 ± .08(19)
4 1/4	.51 ± .10(20)		.61 ± .10(31)	.57 ± .07(51)
4 1/2	.54 ± .09(13)	1.69 ± .00(1)		.62 ± .12(14)
5	.52 ± .08(16)		.47 ± .04(67)	.48 ± .02(83)
TOTAL	.51 ± .02(389)	.73 ± .03(117)	.52 ± .02(479)	.54 ± .01(985)

Table 16. Mean sauger age (± SE) by mesh size, Mossy Bay, July 1965, 1966 and 1967. Sample size is given in parentheses.

Mesh	Year			
	1965	1966	1967	Total
1 1/2	1.68 ± .07(60)	2.44 ± .15(25)	2.64 ± .09(132)	2.35 ± .06(217)
2	2.31 ± .08(100)	3.36 ± .22(25)	3.44 ± .07(146)	3.02 ± .06(271)
2 1/2	2.62 ± .09 (79)	4.16 ± .16(25)		2.99 ± .10(104)
3	2.97 ± .19(32)	4.84 ± .15(31)	4.26 ± .12(81)	4.10 ± .10(144)
3 1/2	3.00 ± .23(31)	4.80 ± .49(5)		3.25 ± .23(36)
3 3/4	2.64 ± .21(22)	5.50 ± .50(2)	3.45 ± .24(22)	3.15 ± .18(46)
4	2.06 ± .17(16)	5.00 ± 00(3)		2.53 ± .29(19)
4 1/4	2.40 ± .26(20)		2.93 ± .31(31)	2.72 ± .21(51)
4 1/2	2.46 ± .27(13)	7.00 ± 00(1)		2.78 ± .41(14)
5	2.44 ± .26(16)		3.16 ± .10(67)	3.02 ± .10(83)
TOTAL	2.41 ± .13(389)	3.90 ± .12(117)	3.29 ± .05(479)	3.01 ± .04(985)

Table 17. Depth distribution of saugers sampled in Mossy Bay, June and July, 1967. Weights given in pounds.

		June			July		
Depth(feet)		0 - 20	21 - 39	40+	0 - 20	21 - 39	40+
No. of sets		4	1	3	5	1	4
Typical substrate		mixed	mixed	sand & clay	mixed	sand & mud	sand & clay
Temp. range	surface F°	47 - 52	49	47 - 48	60 - 64	62	60 - 64
	bottom	-	-	-	52-64	60	52 - 64
Mesh size							
1 1/2	No. of fish	7	-	13	101	3	28
	No./set	1.75	-	4.33	20.20	3.00	7.00
	Av.wt.	.35	-	.24	.25	.61	.40
2	No. of fish	7	5	46	86	2	58
	No./set	1.75	5.00	15.33	17.20	2.00	14.50
	Av.wt.	.46	.51	.62	.44	.62	.51
3	No. of fish	16	13	77	58	4	19
	No./set	4.00	13.00	25.67	11.60	4.00	4.75
	Av.wt.	.77	.86	.97	.93	.88	.85
3 3/4	No. of fish	7	1	47	17	1	4
	No/set	1.75	1.00	15.67	3.40	1.00	1.00
	Av.wt.	1.27	1.75	1.31	.64	1.75	.93
4 1/4	No. of fish	3	1	25	22		9
	No./set	.75	1.00	8.33	4.40		2.25
	Av.wt.	1.37	1.75	1.63	.62		.59
5	No. of fish	1	1	4	58	1	8
	No./set	.25	1.00	1.33	11.60	1.00	2.00
	Av.wt.	2.06	.44	1.73	.46	1.87	.37
TOTAL	No. of fish	41	21	212	342	11	126
	No./set	10.25	21.00	70.67	68.40	11.00	31.50
	Av.wt.	.76	.84	1.01	.49	.93	.55

Table 18. State of maturity of saugers, walleyes, and whitefish taken in experimental nets, Mossy Bay, June and July, 1967. Figures represent percent mature.

	Period	1+	2+	3+	4+	5+	6+
SAUGER							
Males	June	-	75.0	84.2	100.0	100.0	
Females	June	-	-	42.8	55.1	86.2	50.0
Males	July	-	19.0	47.7	86.0	92.9	100.0
Females	July	-	4.3	28.4	45.8	60.0	75.0
WALLEYE							
Males	June	-	-	-	-	-	-
Females	June	-	-	-	-	-	-
Males	July	-	-	-	-	100.0	-
Females	July	-	16.6	40.0	50.0	50.0	-
WHITEFISH							
Males	June	-	-	-	28.6	-	-
Females	June	-	-	16.6	100.0	100.0	-
Males	July	-	-	33.3	77.8	100.0	-
Females	July	-	-	50.0	100.0	100.0	-

Table 19. Mean weight and length (± SE) of walleyes and whitefish, by mesh and age, Dauphin River and Mossy Bay, July, 1966. Sample size is given in parentheses.

	Dauphin River Walleyes		Mossy Bay Whitefish	
Mesh	Length (ins.)	Weight (lbs.)	Length (ins.)	Weight (lbs.)
Mesh				
1 1/2		.19 ± 0 (1)		
2			8.33 ± .09(16)	.38 ± .02(16)
2 1/2			10.44 ± .24(43)	.70 ± .02(43)
3			12.47 ± .36(37)	1.08 ± .07(37)
3 1/2			12.53 ± .31(10)	1.04 ± .08(10)
3 3/4	14.5 ± .14(22)	1.27 ± .11(22)	13.78 ± .39(8)	1.58 ± .08(8)
4			14.36 ± .45(8)	1.63 ± .04(8)
4 1/4	14.4 ± 1.41(6)	1.52 ± .40(6)	14.30 ± .21(8)	1.54 ± .06(8)
5				1.00 ± 0 (1)
Age				
1+		.19 ± 0(1)	8.30 ± .10(2)	.31 ± .02(2)
2+	11.38 ± .05(4)	.59 ± .14(4)	9.21 ± .28(40)	.44 ± .01(40)
3+	13.47 ± .38(11)	1.03 ± .06(11)	11.91 ± .12(54)	.90 ± .03(54)
4+	15.56 ± .27(9)	1.47 ± .12(9)	14.32 ± .12(35)	1.63 ± .02(35)
5+	17.83 ± .13(3)	2.40 ± .02(3)		
6+	18.40 ± 0(1)	2.88 ± 0(1)		

Table 20. Mean sauger weight (pounds) and fork length (inches) by sex and age, Mossy Bay, 1967. Per cent frequencies are given in brackets.

			Age						
			1+	2+	3+	4+	5+	6+	Total
Frequency (%)	June*	females	3 (2.2)	4 (3.0)	28 (20.7)	69 (51.1)	29 (21.5)	2 (1.5)	135
		males	1 (0.7)	11 (8.0)	19 (13.8)	75 (54.3)	32 (23.2)	- -	138
	July**	females	6 (2.2)	47 (17.3)	89 (32.7)	83 (30.5)	35 (12.9)	12 (4.4)	272
		males	7 (3.5)	42 (20.9)	86 (42.8)	49 (24.4)	14 (7.0)	3 (1.5)	201
Weight (± SE)	June	females	.17 ± .00	.37 ± .13	.54 ± .05	.96 ± .05	1.59 ± .08	2.03 ± .00	
		males	.12 ± .00	.35 ± .02	.51 ± .08	1.05 ± .04	1.24 ± .06		
	July	females	.12 ± .01	.23 ± .07	.41 ± .02	.73 ± .04	1.06 ± .07	1.15 ± .10	
		males	.11 ± .01	.21 ± .01	.32 ± .04	.62 ± .05	1.05 ± .12	1.18 ± .04	
Length (± SE)	June	females	8.23 ± 1.24	9.92 ± .95	11.21 ± .32	13.13 ± .20	15.29 ± .26	16.45 ± .25	
		males	7.40 ± .00	9.94 ± .29	10.82 ± .42	13.66 ± .17	14.46 ± .18		
	July	females	6.93 ± .22	8.35 ± .21	10.12 ± .15	12.07 ± .20	13.73 ± .32	14.33 ± .38	
		males	6.93 ± .24	8.27 ± .16	9.61 ± .12	11.49 ± .33	13.58 ± .49	14.47 ± .53	

* sex not determined on 1 sauger

** sex not determined on 6 saugers